Notes on the Life History of Two Californian Pomacentrids: Garibaldis, *Hypsypops rubicunda* (Girard), and Blacksmiths, *Chromis punctipinnis* (Cooper)[1]

Conrad Limbaugh

ABSTRACT: The range, life history, food, competitors, predators, and ectoparasitic cleaners of *Hypsypops rubicunda* and *Chromis punctipinnis* are considered. Both species exhibit elaborate prespawning and spawning behavior. Nest preparation and nest behavior of the garibaldis are discussed in detail.

The pomacentrids are well represented in tropical waters; de Beaufort (1940) listed 88 species divided into 11 genera for the Indo-Australian Archipelago, and Smith (1953) gave 24 species for the South African area. The literature concerning New World species badly needs revising, but there seem to be approximately 20 species, divisible into 8 genera, in the eastern Pacific. One of these genera, *Azurina,* appears to be endemic to the eastern Pacific.

Most of the species are small and often vividly colored. Most exhibit distinct habitat preferences, varying widely from species to species. Such forms as *Hypsypops, Microspathodon,* and *Pomancentrus* are bottom-dwelling and generally take cover in holes in reefs, while *Chromis punctipinnis* and *C. atrilobatus* tend to form schools well off the bottom. The schooling habit is most marked in the slender, graceful *Azurina eupalama* and *A. hirundo.* Members of this family exhibit elaborate prespawning and spawning behavior. Males establish nesting sites which they zealously protect from all intruders both before and after egg-laying activities (Limbaugh, 1955; Longley and Longley, in Longley and Hildebrand, 1941).

Only two pomacentrids are represented in southern California waters: the bright orange garibaldi, *Hypsypops rubicunda,* and the more somber blacksmith, *Chromis punctipinnis.*

GARIBALDI

Brief Description

A garibaldi is a deep-bodied fish with coarse scales. It has a single dorsal fin with about 12 spines and 16 rays. The large male garibaldi has a lump on the forehead. The adults are uniformly bright orange, but the young bear many iridescent blue spots on their orange bodies (Figs. 1, 2) and gradually pass through numerous color phases before assuming adult coloration. The color pattern of the young was first described by Smith (1883). Developmental color phases and their biological significance as well as the biochemical aspects of the pigmentations of young and adults have been discussed by Fox (1936), Hubbs (1947), and Kritzler et al. (1950).

[1] This paper, based on research notes maintained by the author prior to his death, has been organized by Howard M. Feder, Hartnell College, Salinas, California.

Conrad Limbaugh, chief diving officer at Scripps Institution of Oceanography and one of the world's foremost underwater naturalists, had been working on numerous and diverse research projects before he met his untimely death in a diving accident in the Mediterranean, in March 1960. Many of his projects, including this one, were left unfinished. Because of the extensive field notes and photographic records he maintained, it is anticipated that eventually the results of most of his studies can be assembled and published so the vast wealth of his accumulated knowledge will not be lost.

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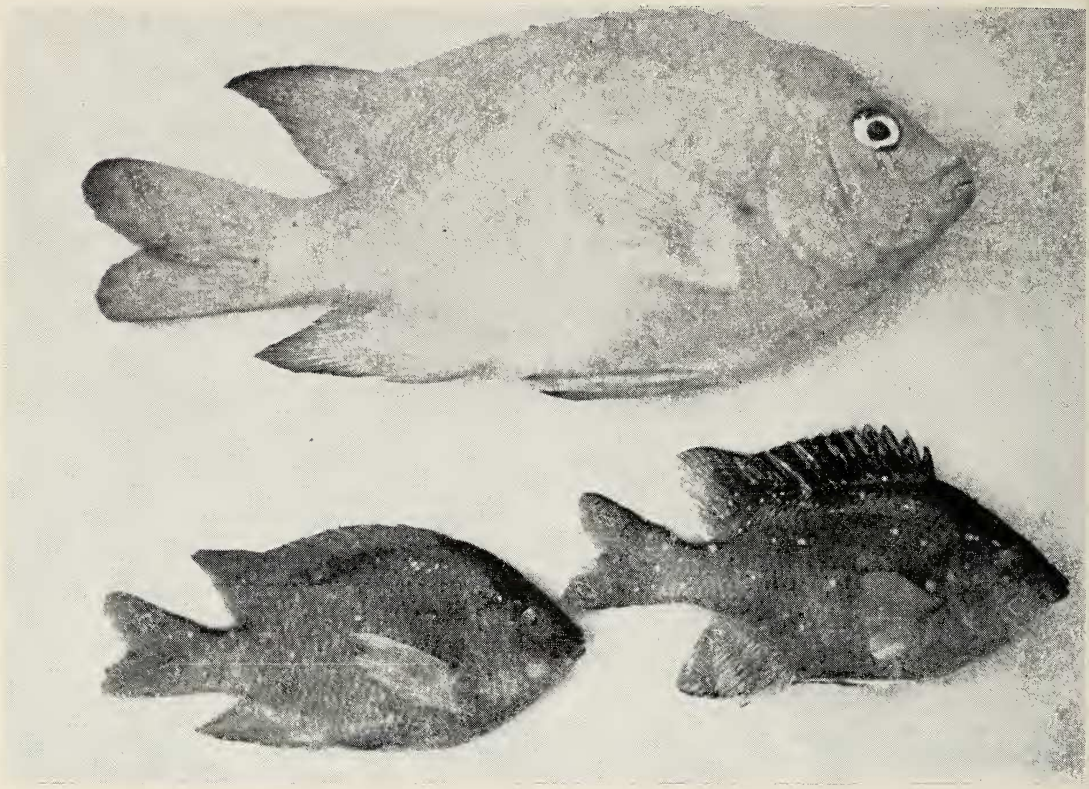

FIG. 1. An adult male (above) and two juveniles (below) *Hypsypops rubicunda.* The adult is bright orange while the young bear iridescent blue spots.

Recorded Range

They have been reported from Monterey, California (Girard, 1858), to Santa Maria Bay, Baja California (Fitch, 1953). The Monterey specimen was regarded as a product of a warming cycle in our coastal waters (Hubbs, 1948); the species typically does not range much north of Point Conception. Extensive diving off the California and Baja California coasts as well as the offshore islands permits listing numerous specific areas in which adult and juvenile garibaldis have been observed (Table 1). I noted adults from Naples, California, to Punta San Rosarita, Baja California, and from Santa Cruz Island to San Martin Island; while juveniles were seen from Malibu Beach, California, to Ensenada, Baja California, and from Santa Catalina Island to the Coronado Islands.

Length

The maximum length recorded for a garibaldi is 35.6 cm, or 14 inches (Barnhart, 1936; Roedel, 1953). The largest specimen I collected was 29.3 cm, or 11.5 inches; it was taken in the northern portion of their range. They attain sexual maturity at about 20 cm, or 8 inches.

Habitat

Garibaldis prefer living over rocky bottoms on exposed or semiprotected coasts where the water is clear. They frequent rocky reefs having plenty of crevices and small caves for cover. On rare occasions individuals have been observed high on a column of the giant kelp, *Macrocystis pyrifera,* apparently searching for food.

Adults have been observed in tide pools and

at depths of 90 ft, depending upon the clarity of the water and the depth of the thermocline. They generally remain above the thermocline, where most of the population is concentrated between 4 and 42 ft. When the water is dirty they remain closer to their rocky retreats.

Juveniles may be found in tide pools and to depths of 40 ft.

Life History

They were present throughout the year in all regions noted in Table 1, and individuals probably remain in a restricted territory during most of their lives. Each fish roams a rather large territory, but there are definite concentrations of individuals in certain areas, possibly depending upon whether or not the environment is favorable. In some cases, these groups may use the same crevices for cover. The individuals in a group were never observed fighting, but tagged fish introduced from other regions were quickly driven away.

Garibaldis defend their territories vigorously, reluctantly retreating from a diver to their rock holes only when directly approached. They generally wait at the entrance if they are not pursued (Fig. 3). If they are further molested, they will enter the hole and either leave by another opening or wedge themselves into a crevice. They may be taken by hand at this time but at the risk of lacerated hands and arms. Disturbed garibaldis generally emit thumping sounds easily heard by a diver.

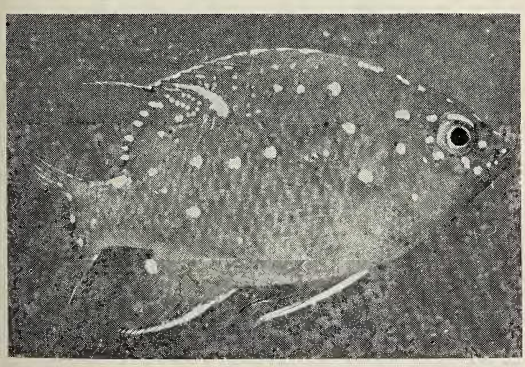

FIG. 2. A young *Hypsypops rubicunda* showing a pattern of spots somewhat different from the juveniles in Figure 1.

TABLE 1

DISTRIBUTION OF ADULT AND JUVENILE *Hypsypops rubicunda*

AREAS (NORTH TO SOUTH)	ADULTS	JUVENILES
Mainland		
Naples	+	
Point Dume	+	
Malibu	+	+
Rocky Cove	+	+
Palos Verdes Cove	+	+
Long Point	+	+
Newport Beach	+	+
Laguna Beach	+	+
Dana Point	+	+
Solana Beach	+	+
Del Mar	+	+
La Jolla	+	+
Point Loma	+	+
Ensenada	+	+
Santa Tomas	+	
Bahia San Carlos	+	
Punta Blanca	+	
Bahia Playa Maria	+	
Punta San Rosarito	+	
Islands		
Santa Cruz	+	
Santa Catalina	+	+
San Clemente	+	+
Coronados	+	+
San Benito	+	
San Martin	+	

The breeding season seems to be continuous throughout the spring and summer. It may begin as early as March and persist through July, lasting longer in warm years and in the southern portions of their range. There may be no spawning season in the northern part of the adult distribution.

All signs of blue are lost in mature adults; the faintest trace of blue is an indication of immaturity. There are slight color and size differences between sexes: males tend to be more reddish (red-orange) and are slightly larger than the females in a given area. No evidence is available to determine if the color difference is seasonal.

The male prepares a nest by cleaning a rocky surface of all but the strongly adherent calcareous organisms. In the center of the cleared area he cultivates an elliptical patch of velvety red algae. Plant material taken from nests off La Jolla,

FIG. 3. An adult male *Hypsypops rubicunda* at the mouth of a crevice, where he has retreated upon the approach of the diver.

California, contained three principal kinds of algae. The most abundant was *Ophidocladus californicus;* the other two species were *Pterosiphonia dendroides* Falk. and *Spermothamnion snyderae* Farlow. A nest from 35 ft of water off Point Loma, California, was composed of algal material not previously described, and may represent a new genus (E. Yale Dawson, personal communication). I could not determine whether the algae grew on the nest site or were placed there by the male. The patch is usually 10 to 12 inches along its major axis. The nest site is always shaded and generally on a vertical surface in shallow water; in deeper water, it is in the open in a horizontal plane. These differences in nest orientation are undoubtedly related to the light requirement of the red algae. The "garden nest" is kept clean and cropped to about ½ inch, while the surrounding rocks for a distance of 10 to 35 cm are kept completely bare by the male's continual activity. The nest is guarded constantly and other fishes, including male garibaldis, are driven off.

Spawning begins shortly after a female from a nearby area wanders into the general vicinity of the nest. The male challenges her when she approaches within 4 to 15 ft of the nest by making very loud thumping sounds and rushing toward her. Unlike the invading males, she does not swim swiftly away; instead she evades the male by darting past him toward the nest. After several challenges, in which the male may bite her, she arrives inside an area where he ceases to challenge her. This area is about a foot in diameter.

Once inside the protected area the female moves slowly back and forth over the garden maintaining her genital area against the plants. The male usually joins her unless he is disturbed by the presence of other fishes. During spawning he is in a highly excited state, characterized by rapid darting motions, frequent challenges of other fishes, and quick returns to the nest. If he joins the female he may keep his genital area next to hers. At this time, quivering vio-

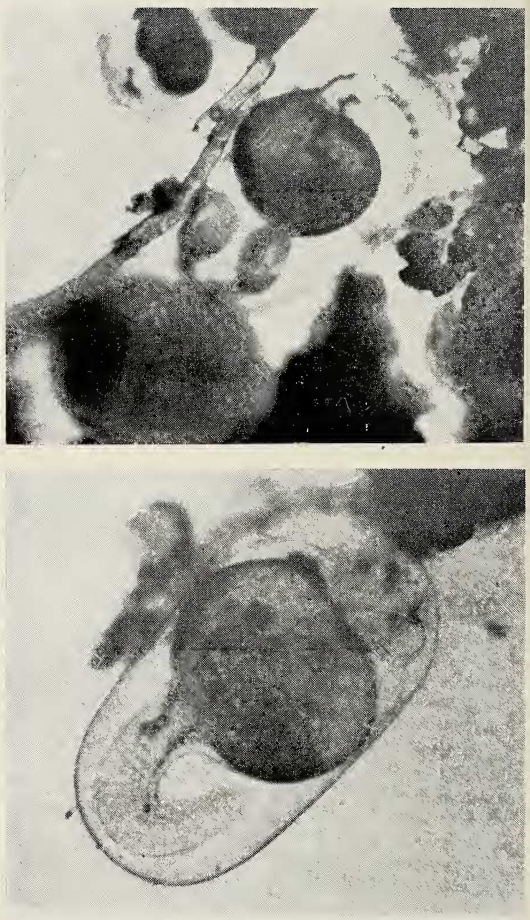

FIG. 4. Two views of the capsule-shaped egg of *Hypsypops rubicunda.* The short threads of attachment extending from that portion of the egg opposite the head of the embryo may be seen in the upper photograph.

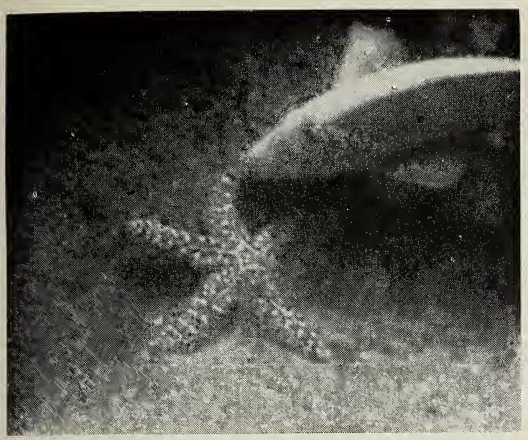

FIG. 5. An adult male *Hypsypops rubicunda* removing a starfish of the genus *Pisaster* that has been placed on the nest by the diver.

lently, he releases sperm on the eggs as they are laid. After the female departs he may go over the eggs again, still in a state of high excitement.

One end of the capsule-shaped egg (Fig. 4) is attached to the red seaweed by short threads. The eggs measure approximately 1 by 2 mm and are orange-yellow in color immediately after they have been spawned. They gradually turn greenish-gray as development proceeds.

The eggs hatch in 2 to 3 weeks in laboratory aquaria maintained at 60–70 F (15.6–21.1 C). However, they do not keep well in laboratory tanks. They hatch only if they are agitated and those that do hatch can be maintained only until their yolk supply is depleted. A few newly hatched young were fed on brine shrimp larvae and some of them survived in the aquaria up to 6 days. In the field the eggs hatch in several weeks and larvae may be collected in near-shore plankton hauls.

The male continues to guard the nest as long as it contains developing eggs. He is very pugnacious, challenging fishes up to 3½ times his own length, biting them and making thumping noises which ultimately drive them away. A nest left unguarded is quickly attacked by other male garibaldis and the eggs are devoured. The resident male on returning will make the encroaching male beat a hasty retreat.

Foreign objects such as shells, stones, crabs, and starfish (Figs. 5, 6) are removed if they settle or are placed on the nest. If the summer waves raise the sand level until it endangers the nest, the male will clean the sand away. Some dig holes as deep as 8 inches around the nests.

Half-inch young appear from July through November. They are brilliantly colored with iridescent butterfly-blue markings over an otherwise translucent orange body, and the heads are striped with blue. As they grow older, the orange color deepens and they gradually lose their blue markings (Figs. 1, 2, 7). These brightly-colored young seek shelter within the tiny crevices of their habitat. As they enter the shade of a crevice the bright blue turns black (because it is a reflected color), and the fish disappears from sight. Young garibaldis are frequently associated with the large red urchin, *Strongylocentrotus franciscanus*. I have collected these young by using SCUBA, a small dip net, and a glass bottle.

The half-grown fish pass through a dull orange stage, when they are much less conspicuous than either the young or the adults. As they

FIG. 6. An adult male *Hypsypops rubicunda* carrying a starfish (shown in Fig. 4) away from the nest area.

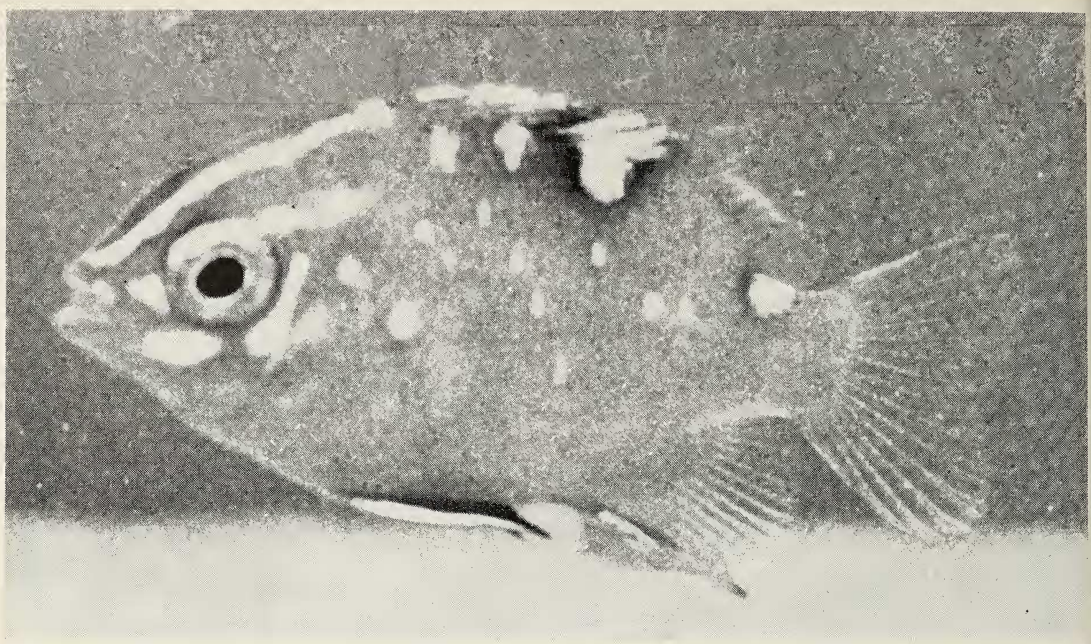

FIG. 7. A very young *Hypsypops rubicunda,* showing the striped head pattern.

reach maturity the last of the bright blue markings, those on the edges of their fins, disappear. Studies of aquarium-grown fish and of size groups in nature indicate that they mature at about 3 years.

Food

Garibaldis probably prefer the bryozoan *Membranipora serrilamella* to all other organisms; most of the stomachs examined contained this species. Some fishery workers feel that in the course of feeding on algae they incidentally take in bryozoan material. Further study is needed to clarify this situation. Other material in their stomachs besides bryozoans and algae included sea anemones, worms, small crabs, amphipods, gooseneck barnacles, clams, snail eggs, and their own eggs.

Competitors and Predators

Spearfishermen represent a potential predator of considerable importance, but garibaldis are now protected by law from this danger. No other predator or competitor has been observed.

Parasites and Cleaning Symbiosis

External parasitic organisms such as bacteria, fungi, copepods, and isopods are removed from garibaldis by senoritas, *Oxyjulis californica,* and kelp perch, *Brachyistius frenatus.* This peculiar habit, which is shared by fishes in many other families in different oceans, has modified the behavior of the parasitized species so that they will seek out cleaner fishes to remove particular parasites. A garibaldi will often hold its operculum open so that a senorita can remove gill parasites. In addition to these two fishes the red and white shrimp, *Hippolysmata californica,* has been observed removing parasites from garibaldis (Limbaugh, 1955; 1961 *a, b*).

Garibaldis' Future

These fish are quite common, although they are less abundant than before spearfishing started. They are now partially protected by law, and wisely so, because they are very easy to spear or capture and might stand a real danger of extermination. Although they are still taken in quantity for aquarium use, especially the

juveniles, by collectors having commercial licenses, the population will probably regain its former abundance, and their beauty will continue to afford pleasure to underwater observers.

BLACKSMITHS

Brief Description

Blacksmiths are oblong fishes with heavy scales and rather blunt heads. The single dorsal fin has 13 spines and usually 12 rays, and there are two spines located at the front of the anal fin. They are blue-gray in color with small black dots on their backs, the soft portion of the dorsal fin, and on the caudal fin. The young-of-the-year are gray-blue anteriorly and yellow-orange posteriorly and have an iridescent blue margin around their dorsal, caudal, and anal fins. Kritzler et al. (1950) briefly described their color patterns.

Recorded Range

The blacksmith extends from Monterey Bay (Radovich, 1961) to central Baja California (Roedel, 1953). I have observed them while diving at Point Dume, Rocky Cove, Long Point, Newport Beach, La Jolla, and Point Loma along the mainland coast, and around the islands of Santa Cruz, Santa Catalina, San Clemente, Los Coronados, and Guadalupe.

Size

The 11-inch specimen reported by Radovich (1961) appears to be the largest known. The largest adults I observed while diving were about 25 cm long. Blacksmiths mature in the La Jolla area when they are about 14 cm long (5.5 inches) and 2 years old. Observations suggest that they are somewhat larger at maturity in the northern part of their range.

Habitat

They live over steep rocky banks and among tall seaweeds as well as around rocks; they generally face the incoming currents. Adults have been found from the surface to 150 ft, and they probably visit depths of 300 ft or more; however, the average depth of adult occurrence is 30 ft. The young are found from the surface to about 50 ft.

Life History

They are extremely abundant throughout the year in southern California waters. Young and adult blacksmiths school or aggregate in definite size groups. In general, the smaller fish are found in shallower water, although large adults live in shallow water in the northern portion of their range. They may be found in loosely-oriented schools, or, when molested or pursued, in large, well-oriented, compact schools.

In the northern and central portion of their range adults are ripe in June and July. Eggs obtained by stripping were cherry red and relatively large, approximately 1.5 mm in diameter. Turner and Ebert (1963) observed the blacksmiths breeding and nesting at Santa Catalina Island, California, in the summer of 1961. The blacksmiths

laid their eggs back in holes and small caverns that were made by 15 to 30 pound rocks that formed a tumbled slide running offshore. They were nesting from 12 to 80 feet beneath the surface and probably deeper. The male first cleared an area and then herded a female into his "den" by biting and otherwise harassing her. From the egg counts and varying states of development probably more than one female laid eggs in a single nest. The masses of eggs were salmon pink when laid, oblong and adhered by means of filaments (up to 7) at one end of the egg. The male guarded the nest very pugnaciously during brooding. Actual egg-laying could not be observed because the nesting holes were too small at the entrance to permit peeking in. Whenever a guarding male was driven off a whole horde of fishes would swarm in to eat eggs.

The juveniles appear in large, semipelagic schools in August, September, and October; they are ½ to 1 inch long at this time. By November only a few 1-inch-long specimens can be found in the central portion of their range. To the south, however, (Guadalupe Island) they occur as ½-inch young into November. By June of the following year they are between 2 and 3 inches long.

The blue-and-yellow juveniles school densely in the open ocean, sometimes entering kelp beds. As they grow larger they settle in shallow sandy

areas protected by large rocks. Yearling blacksmiths are somewhat more solitary, seeking refuge in small caves and crevices.

Food

When larval fishes, small crustaceans, and young squid are abundant in the plankton, large schools of blacksmith, señoritas, and kelp topsmelt, *Atherinops affinis cedroscensis,* often intercept the inflowing current moving into a kelp bed. Screens of these fishes filter the tiny organisms from these currents; their activities probably materially affect the amount of plankton entering the kelp beds.

Blacksmiths, as well as most of the other fishes of the kelp canopy, utilize the extremely abundant opossum shrimp, *Mysidopsis californica,* for food. *Hyale frequens* and other small amphipods also serve as their food.

Predators

A number of animals have been observed preying on blacksmiths: moray eels, *Gymnothorax mordax,* kelp bass, *Paralabrax clathratus,* ling cod, *Ophiodon elongatus,* and Brandt's cormorants, *Phalacrocorax penicillatus.* Their great abundance indicates that blacksmiths are probably important forage fish.

Parasites and Cleaning Symbiosis

Juvenile pile perch, *Damalichthys vacca,* and señoritas have been observed cleaning parasites from them (Limbaugh, 1955; 1961 *a, b*).

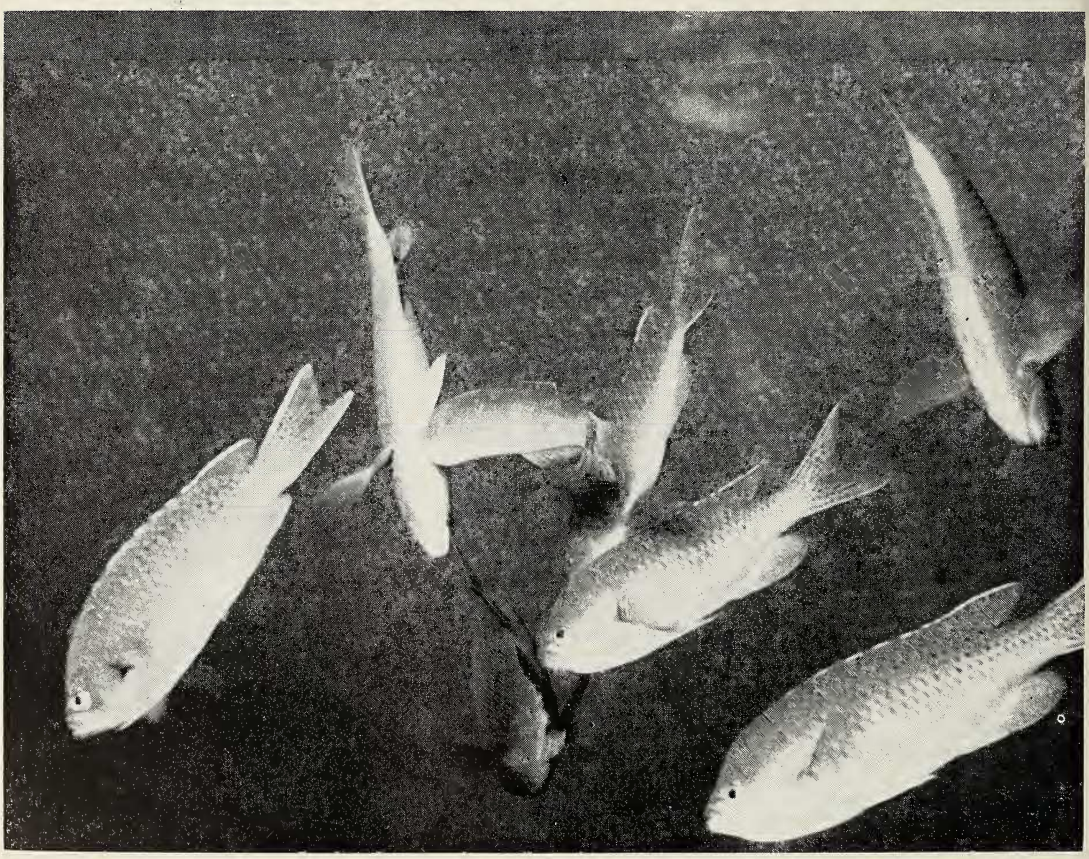

FIG. 8. A señorita (*Oxyjulis californica*) cleaning a *Chromis punctipinnis.* Other individuals are waiting to be cleaned. Note the awkward position assumed by the one being cleaned. (Photograph by Charles H. Turner, State of California Department of Fish and Game.)

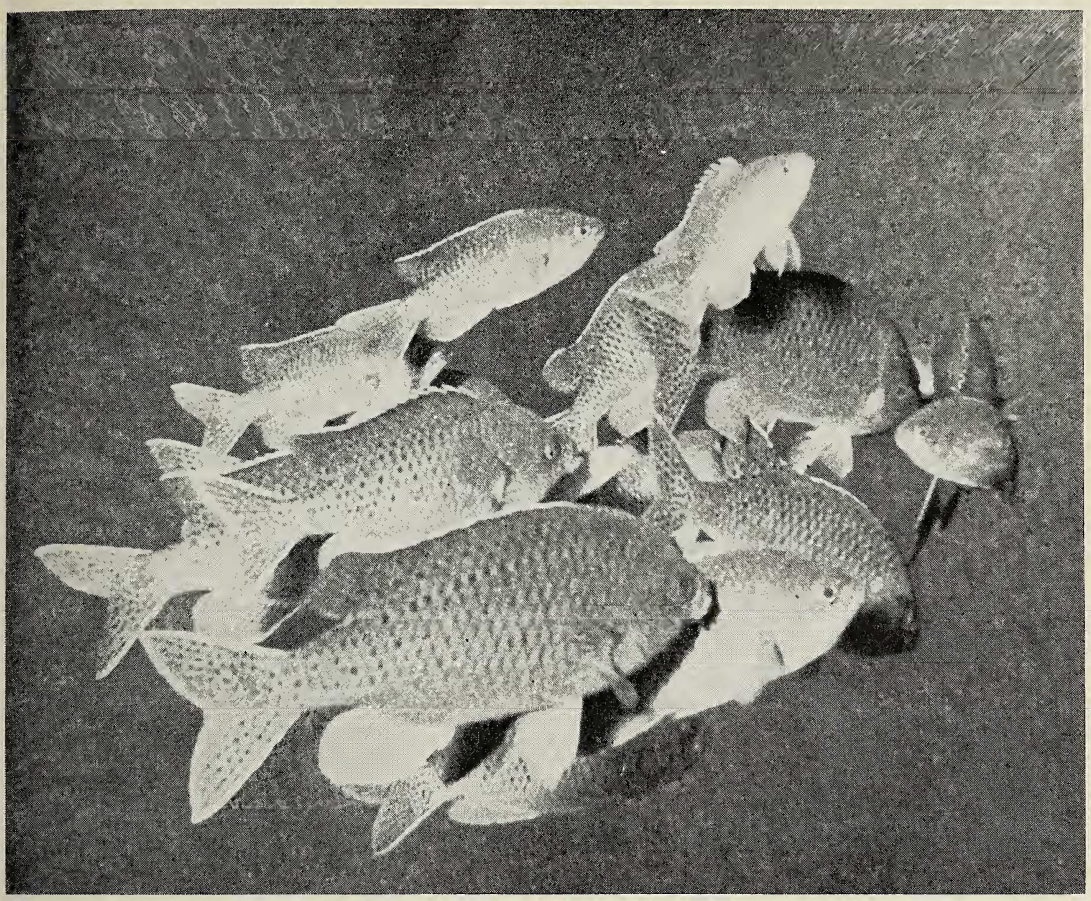

FIG. 9. A tight group of blacksmiths almost completely hiding an *Oxyjulis californica*. The *Oxyjulis* may be seen in the center of the school and only his head is visible. (Photograph by Charles H. Turner, State of California Department of Fish and Game.)

Subadults seek out cleaning fishes and aggressively place themselves in positions that make it almost mandatory for the cleaners to feed on their external parasites (Fig. 8). Groups of blacksmiths completely hiding a cleaning fish are a common sight over shallow rocky reefs (Fig. 9). While having their parasites removed they will assume almost any position: on their sides, heads up, heads down, or even upside down. If the cleaner should try to leave, they will follow and crowd in front of it preventing its escape.

Use as Food

They are sometimes found in the fresh fish markets (Barnhart, 1936), and they form a very small proportion of the southern California "perch" catch (Roedel, 1953). The quality of their flesh is excellent but they are seldom caught on hook-and-line because of their small mouths and general feeding habits.

The blacksmith population remains at a high level.

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